Scenarios for a Clean Energy Future

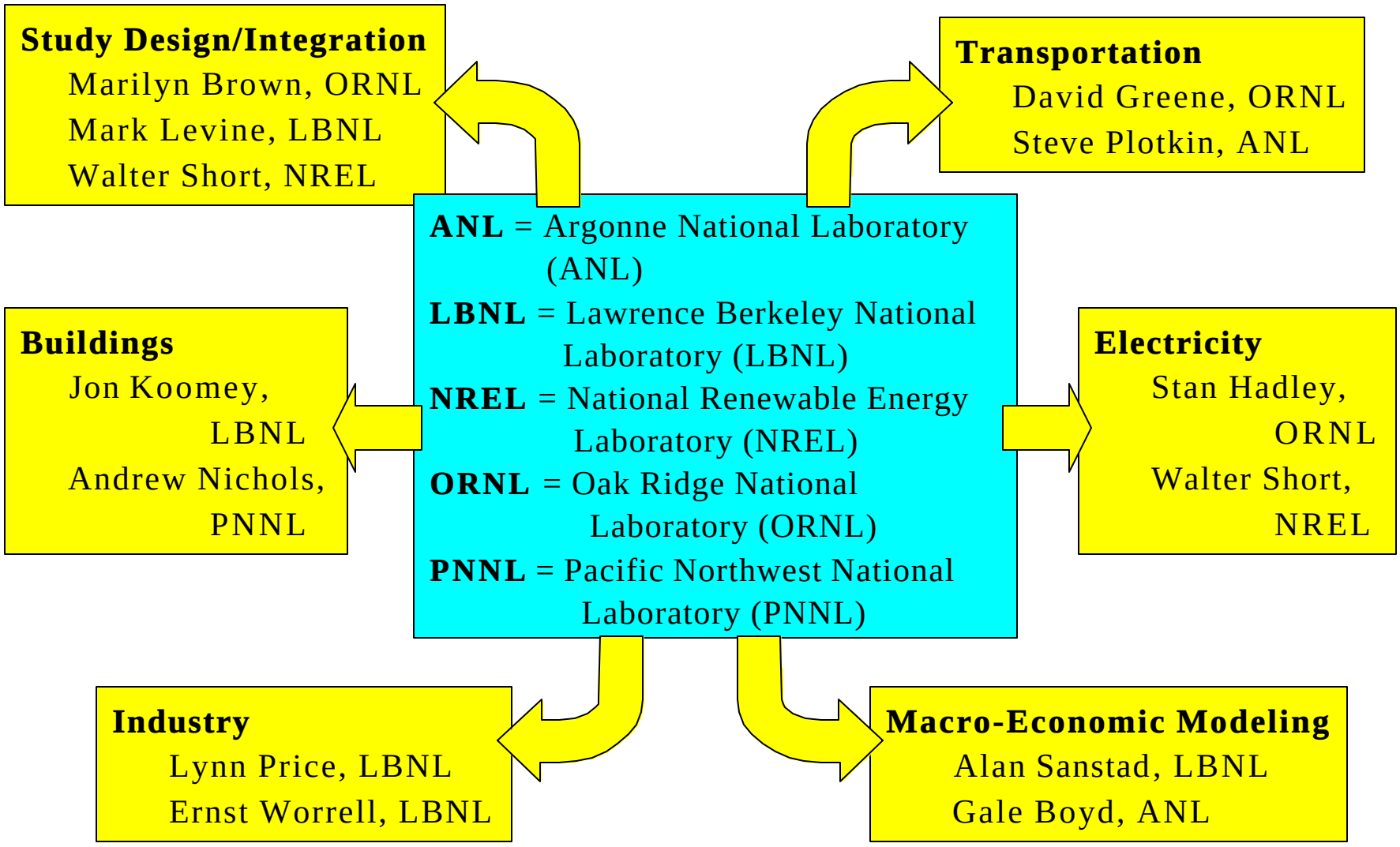
Marilyn A. Brown, Oak Ridge National Laboratory
Mark D. Levine, Lawrence Berkeley National Laboratory
Walter D. Short, National Renewable Energy Laboratory

http://www.ornl.gov/ORNL/Energy_Eff/CEF.htm

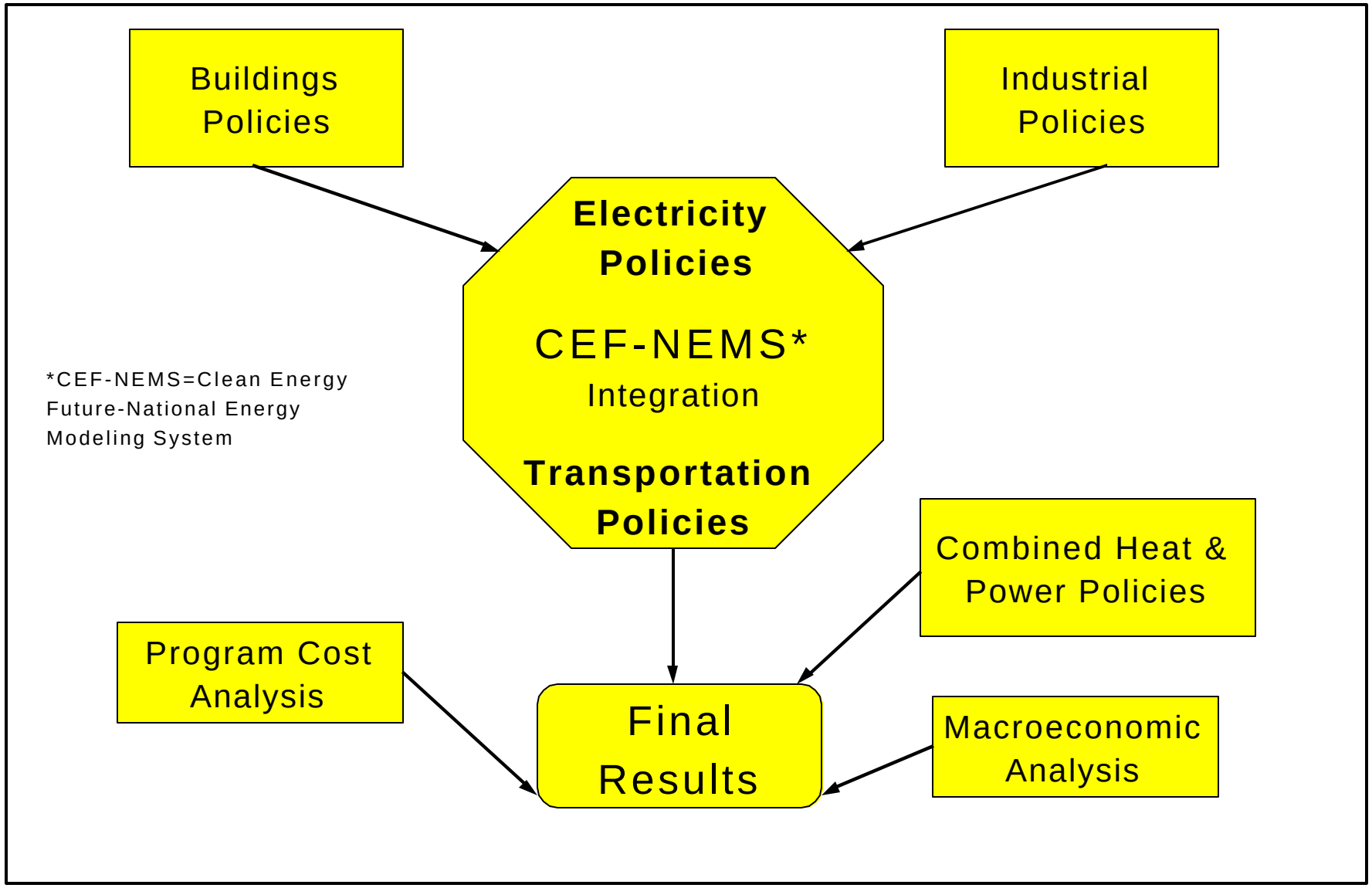
BACKGROUND

- Initiated by the U.S. Department of Energy in November 1998
- **Goal:** to identify and analyze policies that promote efficient and clean energy technologies to reduce CO_2 emissions and improve energy security and air quality
- **Structure:** Analysis undertaken by researchers at 5 DOE national laboratories with input from experts groups
- Published in November 2000

LABORATORY TEAM LEADS



APPROACH


Buildings Policies
Industrial Policies
Electricity Policies
CEF-NEMS*
Integration
Transportation Policies
*CEF-NEMS=Clean Energy Future-National Energy Modeling System
Combined Heat & Power Policies
Program Cost Analysis
Final Results
Macroeconomic Analysis

THREE SCENARIOS

Business-as-Usual: assumes a continuation of current energy policies and a steady pace of technological progress.

Moderate Scenario: relatively non-intrusive, low-cost policies reflecting an increased level of national commitment to energy and environmental goals.

Advanced Scenario: more vigorous policies reflecting a nationwide sense of urgency to address energy-related challenges.

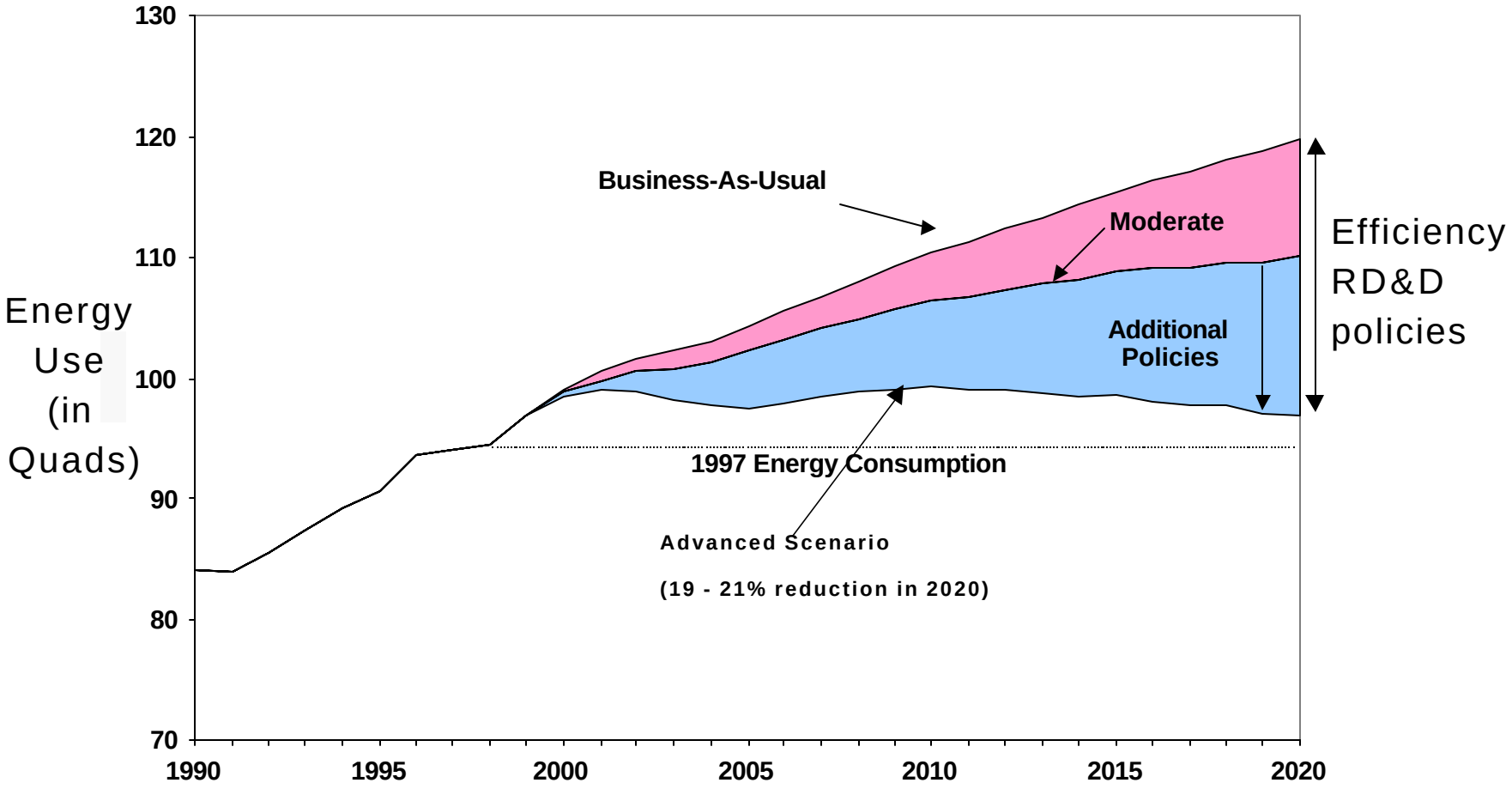
The policy scenarios are not forecasts or recommendations; they are possible pathways to a cleaner energy future.

KEY POLICIES-
ADVANCED SCENARIO*

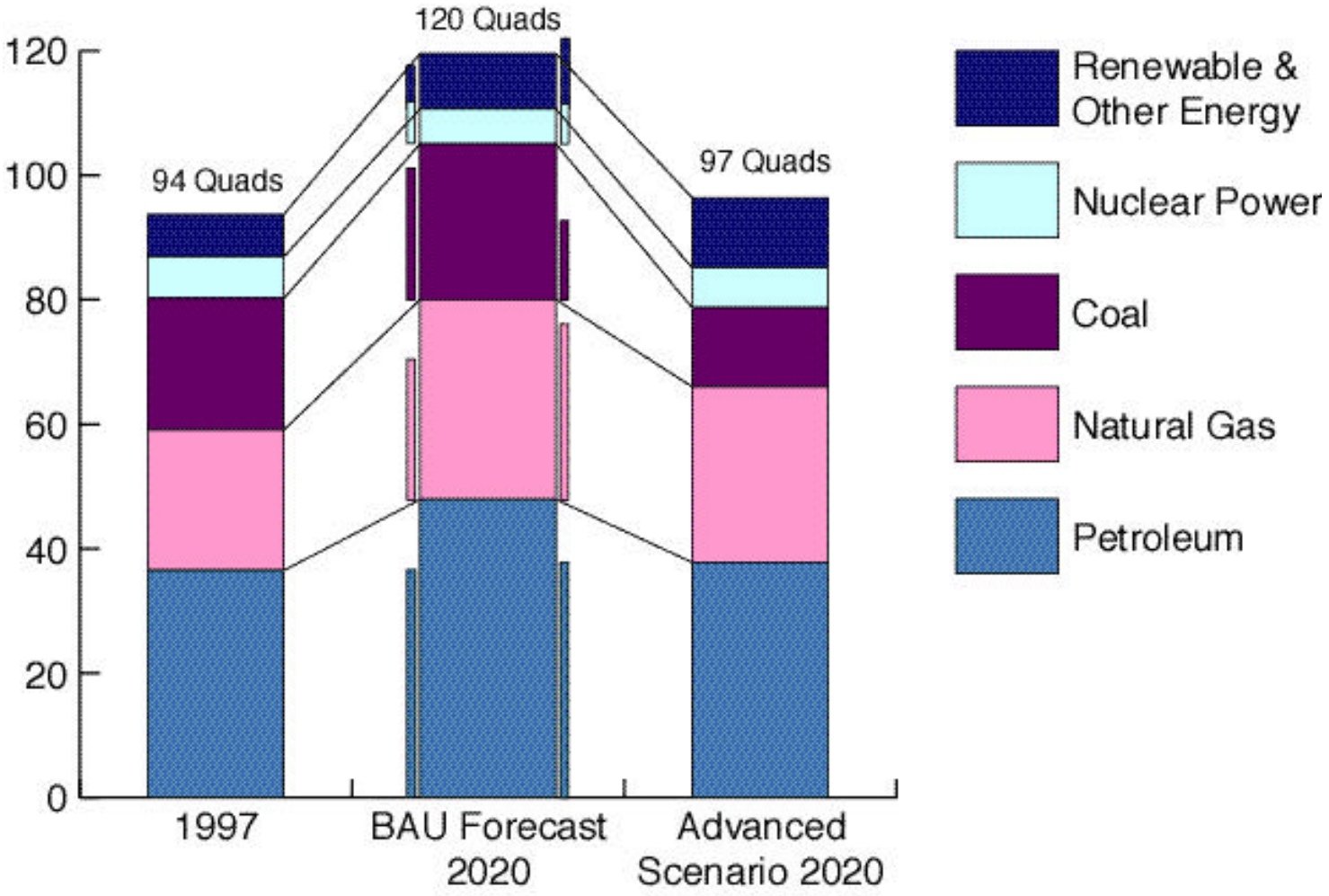
Buildings	Industry
– Efficiency standards for equipment – Voluntary labeling and deployment programs	– Voluntary programs to increase energy efficiency – Voluntary agreements with individual industries
Transportation	**Electric Utilities**
– Voluntary fuel economy agreements with auto manufacturers – "Pay-at-the-pump" auto insurance	– Renewable energy portfolio standards – Production tax credits for renewable energy
Cross-Sector Policies	
– Doubled federal R&D	– Domestic carbon trading system

*The scenarios are defined by approximately 50 policies. These 10 are the most important ones in the Advanced scenario. Each policy is specified in terms of magnitude and timing (e.g., “431 kWh/year dishwasher standard implemented in 2010”).

SCENARIO ENERGY REDUCTIONS

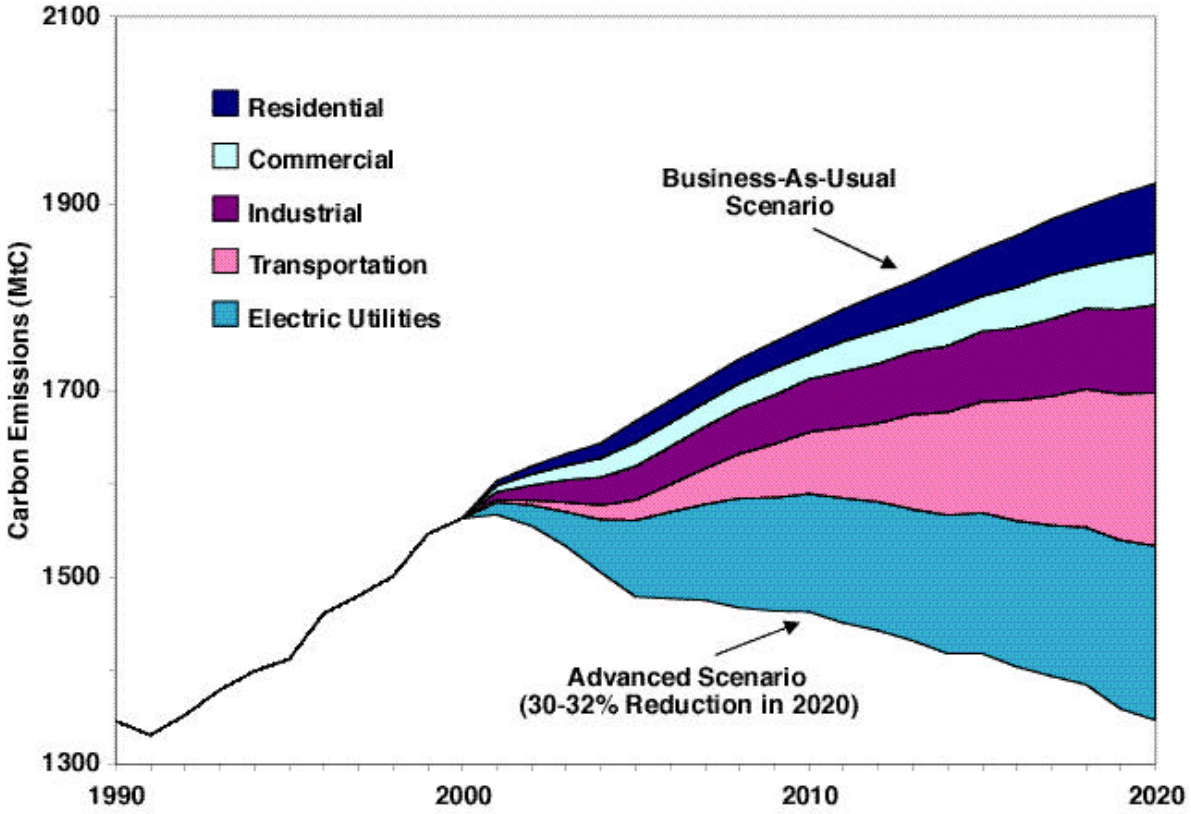


SOURCES OF ENERGY



Scenarios for a Clean Energy Future

SECTORAL CONTRIBUTIONS TO CARBON REDUCTIONS



Need for R&D delays impacts on transportation, but by 2020 emission reductions are large.

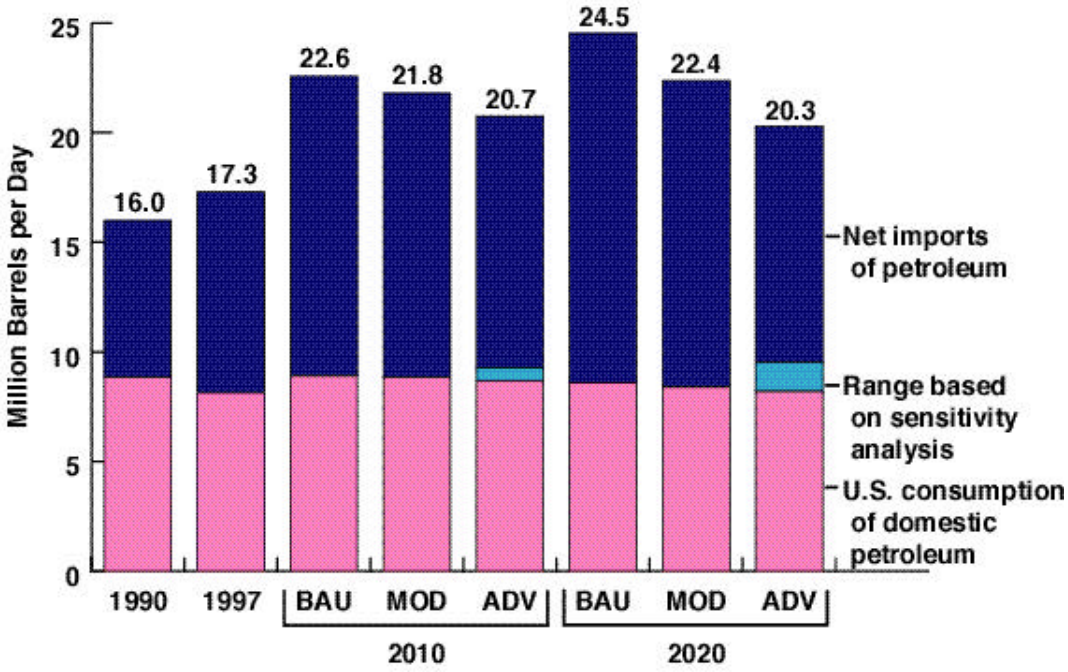
Electric sector policies account for a third of the carbon reductions in the Advanced scenario.

The Oil Story

The Advanced scenario reduces U.S. oil consumption in 2020 (relative to the “business as usual” forecast) by " 4 mmbd. Instead of importing 65% of our oil in 2020 (as forecasted), the U.S. imports only 56%.

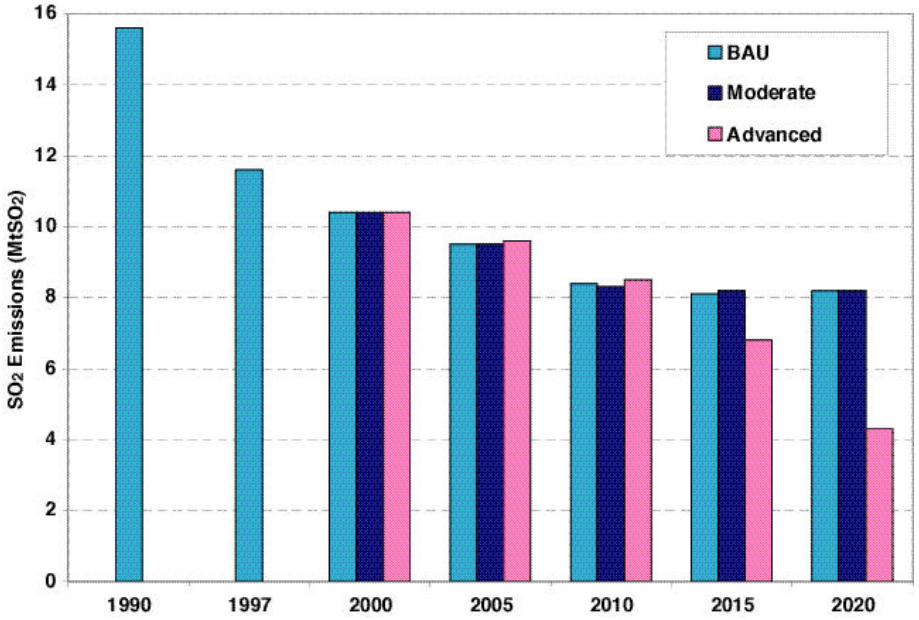
1997: $1.21/gallon gasoline and 20.5 mpg average light duty vehicle = 5.90¢ per mile

2020 in Advanced Scenario: $1.69/gallon gasoline and 28.3 mpg average light duty vehicle = 5.98¢ per mile



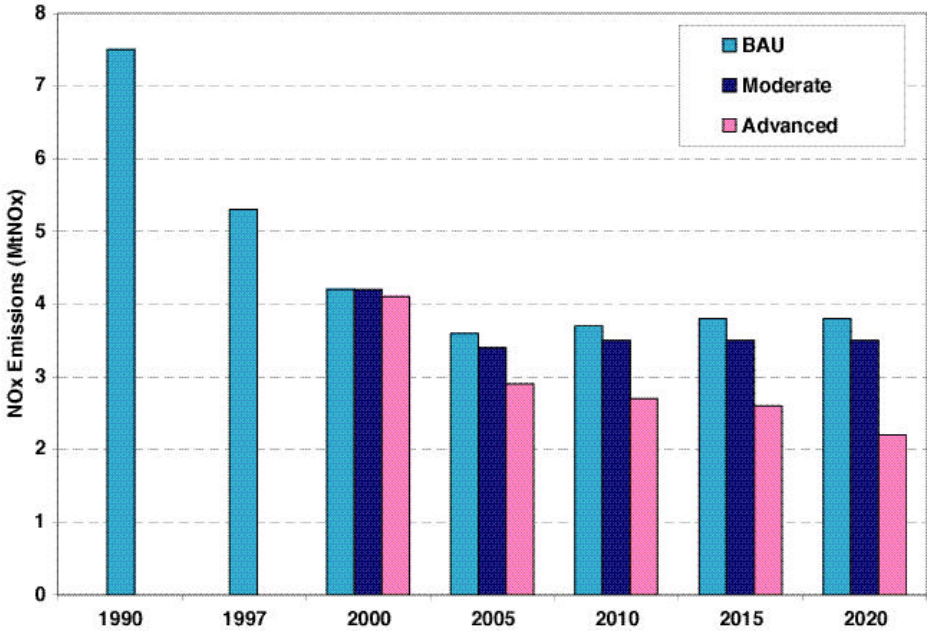
U.S. Consumption of Domestic and Imported Crude Oil and Petroleum Products

The Clean Air Story



SO_2 Emission Reductions
from Electric Generators

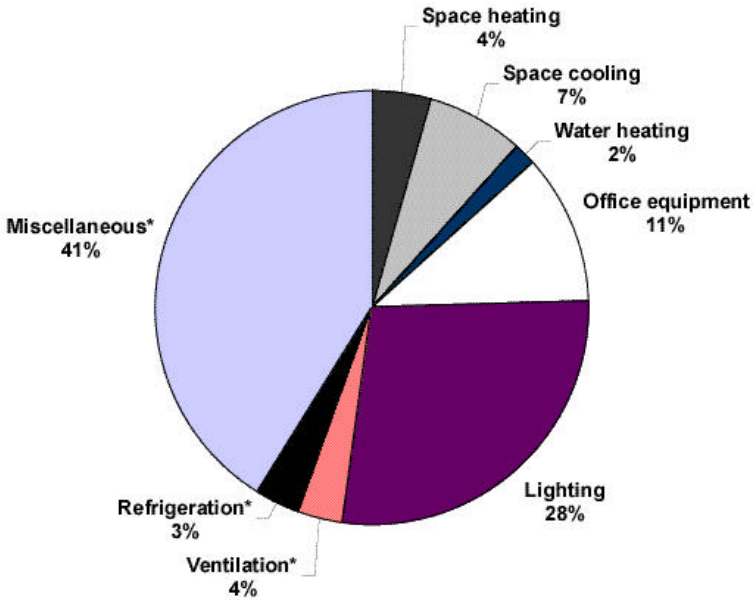
NO_x Emission Reductions
from Electric Generators



Commercial Buildings

- Voluntary programs and equipment standards are the key policy mechanisms.
- End uses with the greatest savings are lighting, office equipment, heating & cooling, and “miscellaneous.”

High-efficiency office lighting



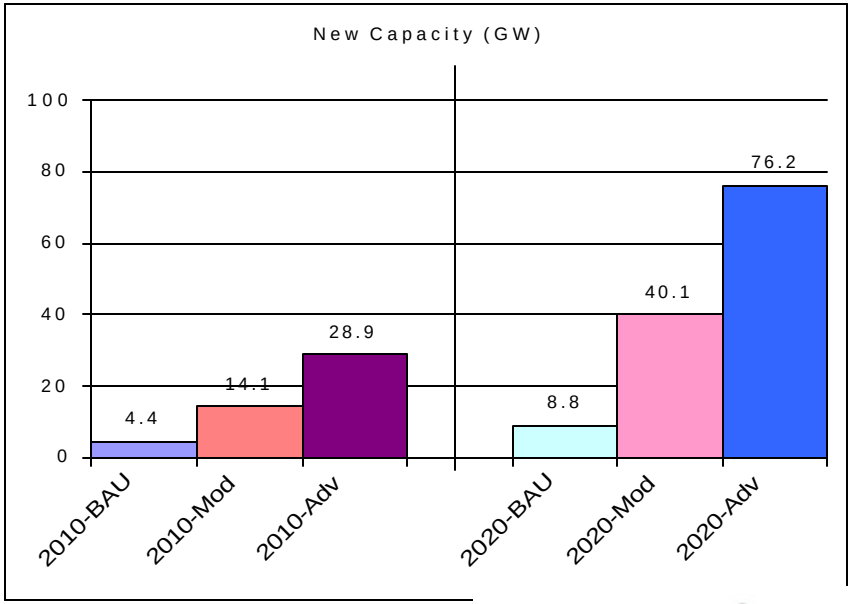
Carbon Emission Reductions from the Advanced Scenario,, 2020

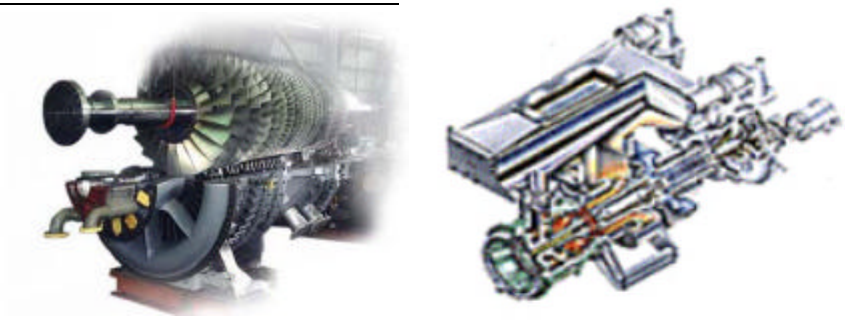
Scenarios for a Clean Energy Future

Absorption -based chillers and heat pumps

Combined Heat and Power

- BAU New Capacity:
  - ⇨ 4 GW by 2010
  - ⇨ 9 GW by 2020
- Advanced Scenario New Capacity:
  - ⇨ 29 GW by 2010
  - ⇨ 76 GW by 2020
- In 2020, this saves:
  - ⇨ 2.4 quads of energy
  - ⇨ 40 MtC of emissions

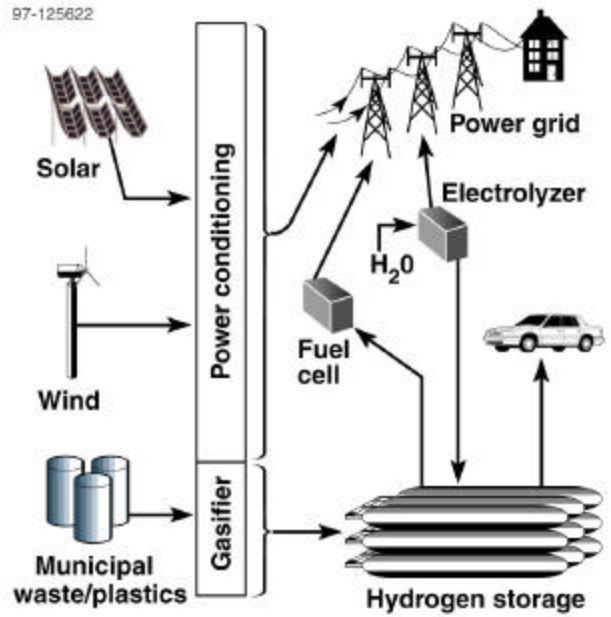




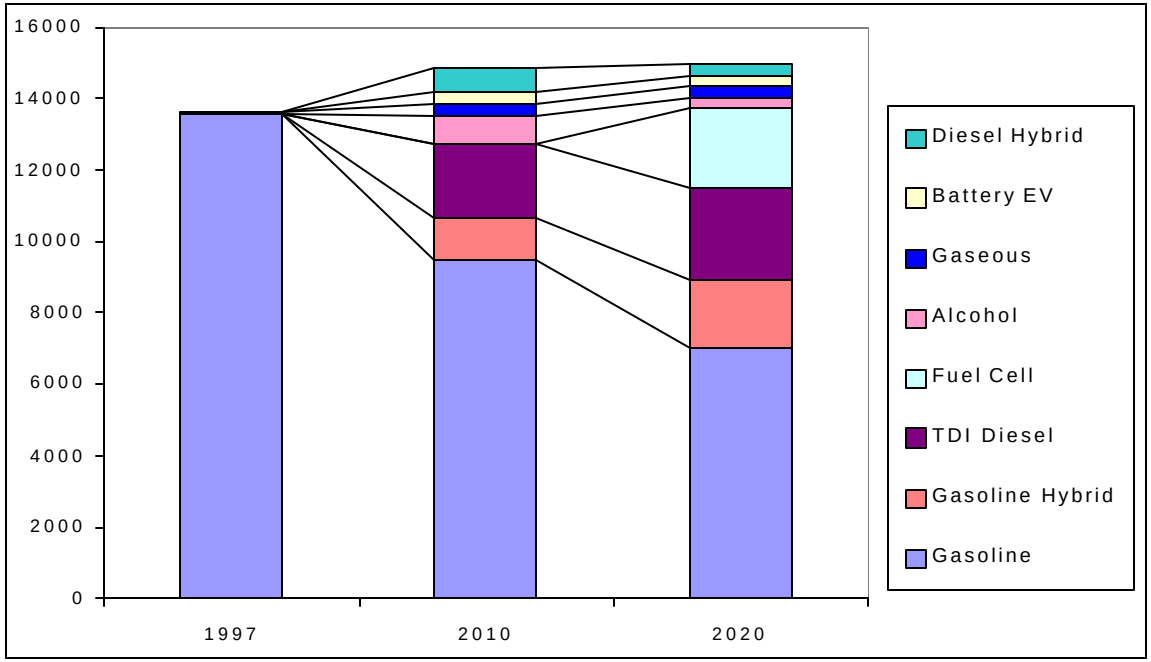
2010-2020: Broad product lines of cost- reduced advanced gas turbines

Transportation

Turbo-charged direct injection (TDI) diesels and hydrogen fuel cell vehicles play a major role by 2020.

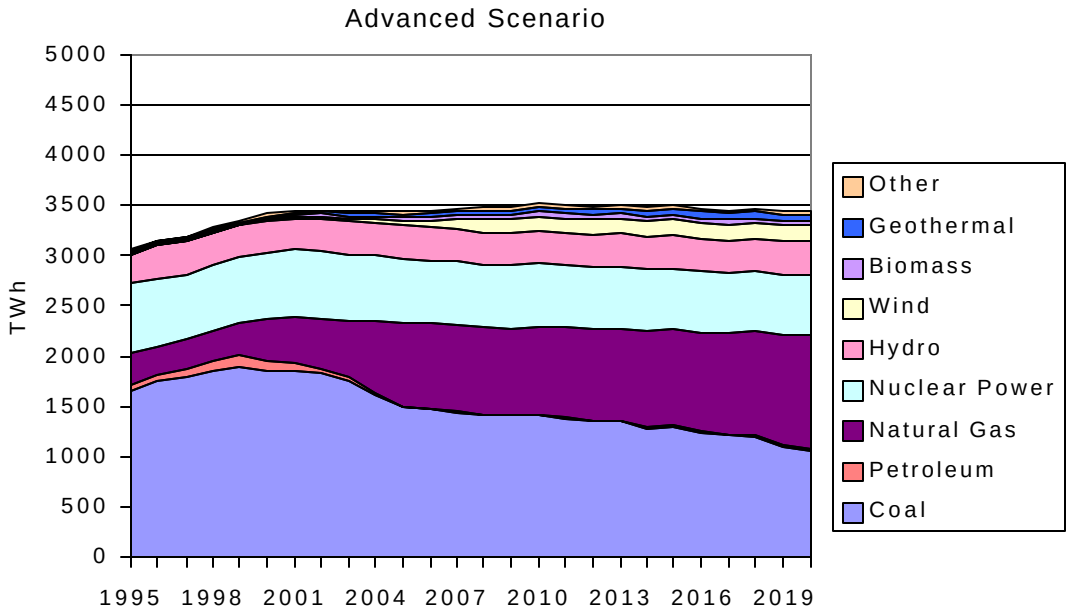


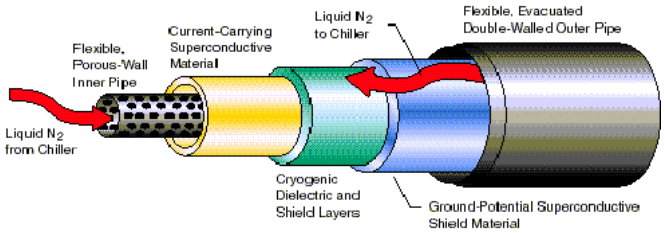
Sales of New Vehicles (in 1,000s)



R&D drives down the cost of a hydrogen fuel cell system to only $1,540 more than a gasoline vehicle in 2020.

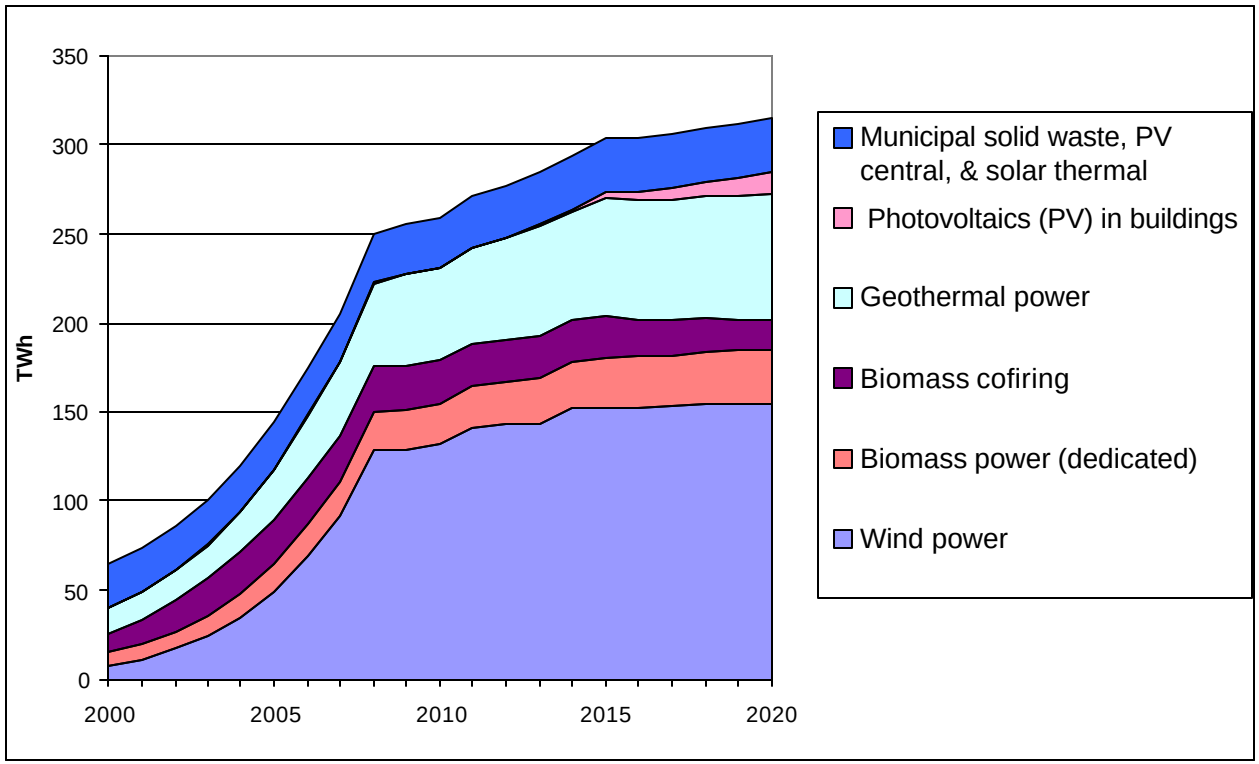
Total Generation by Fuel (TWh)





High-temperature superconducting cable

Renewable Electric Generation in the Advanced Scenario (TWh)



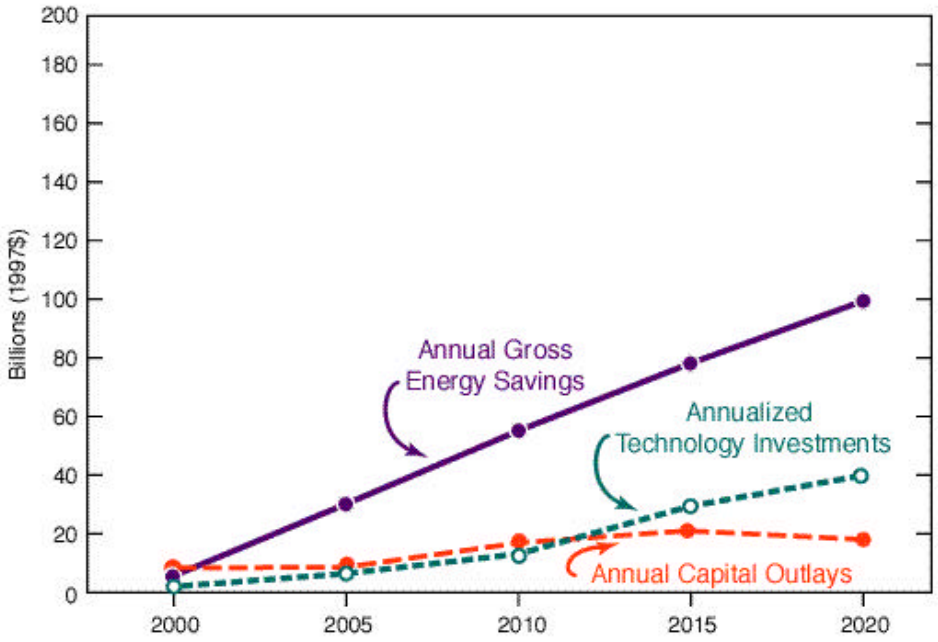
Advanced wind turbine design

COSTS AND BENEFITS

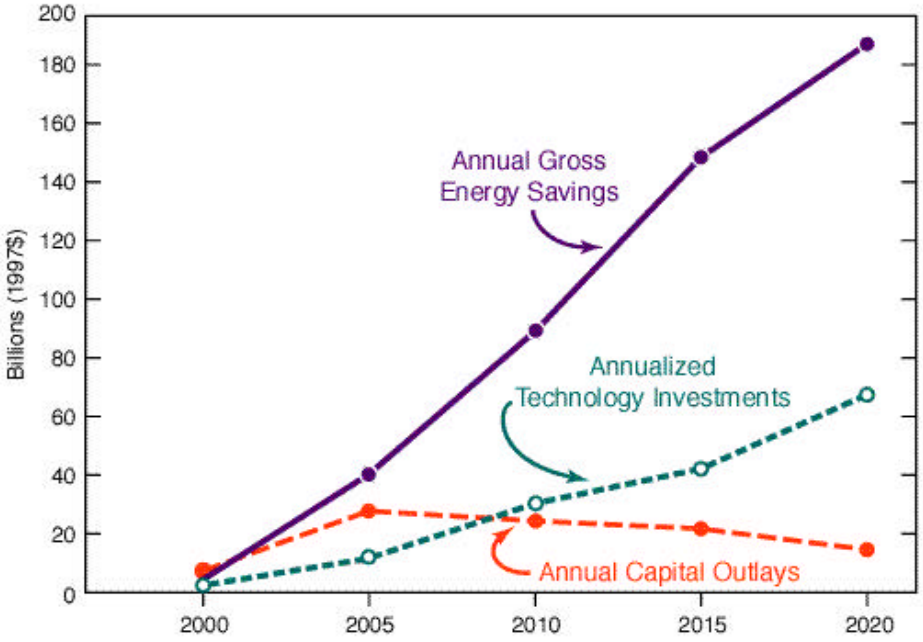
- Premises of study:
  - Market failures and barriers prevent the efficient provision of energy services.
  - Policies can serve to ameliorate this.
  - Nonetheless, energy price changes can have macroeconomic costs associated with them.
- Approach:
  - Estimate net (direct) costs and savings from individual policies utilizing CEF-NEMS.
  - Utilize a meta evaluation of Energy Modeling Forum results to reflect macroeconomic (indirect) effects of changes in energy prices.

THE ECONOMICS:

Energy savings exceed investment costs in both scenarios, and the gap grows over time.



Moderate Scenario



Advanced Scenario

THE ECONOMICS (cont.)

- Indirect macroeconomic costs are in the same range as these net direct benefits.
- Important transition impacts and dislocations could be produced (e.g., reduced coal and railroad employment).
- At the same time, “green” industries could grow significantly (e.g., wind, agriculture, and energy efficiency).

CONCLUSIONS

1. Smart public policies can significantly reduce not only carbon dioxide emissions, but also air pollution, oil imports, and inefficiencies in energy production and use.

2. The overall economic benefits of these policies appear to be comparable to their overall costs.

3. Uncertainties in the CEF assessment are unlikely to alter these conclusions.